

## **Low-energy RHIC electron Cooler (LEReC) progress updates**

**June 7, 2016:**

### **Physics Support:**

- Gun test + extraction line optics frozen. Optics is flexible enough to accept beam at 0.4, 1.6 or 2.6 MeV. Magnets have been selected and checked for their strength.
- Data for 10kW beam dump simulation was provided.

### **DC gun and cathode system:**

- Finished preliminary design drawings for the cathode puck insertion system. Drawings are under checking. Central shop is quoting on the fabrication cost.
- Magnetic manipulators for the cathode puck insertion system are on order.
- Received the complete order for the two stacks of HV ceramic breaks from Friatec, which will be the spare for the DC gun system.
- Assembled the electrode assembly and the ceramic breaks onto the gun chamber in the clean room at Cornell. Precision Survey and adjustment will follow.
- Finished the design of a test setup, which can support a puck heater and a cathode puck. This setup will allow to measure the temperature on the cathode puck, inside a vacuum chamber, during the heating process. The same idea will apply to the cathode production system design later. Most of the components for the setup had been received.

### **Cathodes:**

- a) Room to house R&D fabrication system is getting ready
  - a. Electrical system ready
  - b. Air handling system ready
  - c. Pathway for cathode transport has been cleared
- b) R&D Fabrication chamber
  - a. Platform to house the chamber has been machined, assembled and wired
  - b. Chamber has been designed
  - c. Most of the components have been purchased
  - d. Components are being machined prior to welding
- c) Effusion cell:
  - a. Has been designed, fabricated and tested successfully in a different chamber
  - b. Bulk alkali metal has been procured
- d) Cathode fabrication recipe
  - a. Based on existing literature, a baseline recipe is ready
  - b. Alkali sources for NaK<sub>2</sub>Sb has been procured

### Laser:

- Measurements of laser synchronization, time jitter, laser power stability, and beam position instability are under way:
- Locking to a new low phase noise signal generator, the RMS time jitter is varying from 650 fs to 850 fs [10 Hz to 1 MHz], meeting the design specification.
- Stability of IR laser power around 100 W is measured behind the main amplifier. Within 30 minutes, the std. deviation is about 0.25%.
- Work on laser stability at different amplifier stages is in progress.

### RF and cavities:

- **2.1 GHz Warm RF Cavity**
  - Fabrication of the cavity is underway. RI has completed the machining of a few components (see attached pictures).
  - Pre-braze RF measurement is scheduled for June 22-24<sup>rd</sup> at RI. BNL staff will be traveling to witness the test.
  - Tuner actuator PO has been awarded.
  - Tuner plunger drawings were completed and has been sent to the manufacturer. PO was submitted and awarded.
  - JLab RF windows have been successfully tested. We are waiting on JLab to send the final results so that BNL can select which 4 windows they would like to have shipped to us.
  - Estimated delivery 7/12/16
- **704 MHz Warm RF Cavity:**
  - Work continues on the detailed design of the cavity. The design changes on the cooling system layout delayed the final design review by 10 days. The final design review is scheduled to happen by June 22<sup>nd</sup>.
  - Design of the tuner is still on going.
  - Estimated delivery 10/10/16
- **Booster Cavity Waveguide Layout**
  - Waveguide layout in the tunnel and outside has been completed. The PO will be placed by June 10<sup>th</sup>.

### Magnets:

- DC gun solenoids went into requisition process.

### Power Supplies:

- **Gun Injection Section:**

-All ps's agreed upon.  
- Some ps's will be used from ERL.  
- PO has been written for the new ps's for Corr 24H,V, Corr 25H,V and Corr 26 H,V

- **180 deg. dipole PS:**

Assembling and testing is in progress.

### **Beam Instrumentation:**

- **GUN-to-BOOSTER INSTRUMENTATION:** Profile Monitor mechanical design complete; working on optics for PM and cathode imaging; implementing fiber feedthroughs for remote PMT arc detectors in HVPS SF6 tank; working on solution for fast anode DC current measurement plus bias.
- **GUN TEST B/L INSTRUMENTATION:** Profile Monitor mod'd with 25mm round YAG – nearing completion; Multi-slit Emittance slit mask chosen – waiting on designer for mechanical design; DCCT shield installed; ICT shield waiting on final drawing; profile monitor mod's underway; 4 Halo Monitors in one cross – waiting chamber design.
- **The BPM** housings, button pick-ups and V301 electronics modules have been ordered. Still to be ordered for the BPM system are the local amplifiers & switch boxes and heliax cables & connectors. Several of the BPMs in the RHIC cooling region are now connected to local amplifiers in the tunnel and V301 electronics in the 1002D trailer, system performance is being evaluated when RHIC beams are available.

### **Beam dump:**

- 45° Diagnostic Dump & Stand
  - Received file containing energy deposition of 0.4 MeV electrons into dump for modelling heat dissipation / temperature rise in dump.
  - Designer assigned to work on dump stand. (Shielding TBD.)

### **Controls (including MPS and Timing):**

- Requisitions issued for most hardware purchases
- Established a ballpark response time and awaiting simulation results to finalize this number. So far, we estimate the calculated 30us time to change to about 10us or so.
- For Fall 2016, we will only engage the MPS if the laser power or the pulse rate passes the set threshold. This means 2 inputs for the MPS. Instrumentation is looking into how to measure the laser power and create a digital output for the MPS.
- Discussion of Timing is in progress.

### **Cryogenics:**

- **IP2 CRYOGENICS**

Cryo lines: The cryo lines layout was revised to accommodate changes to platform for the optics bench for laser beam SOW and technical specs in progress.

2K/4K heat exchanger drawings and spec completed and signed off. To be released for procurement.

P&ID reviewed and tags to be updated with new tags numbers for new equipment/instruments relative to ERL instruments that will move with cryostat

- 704MHZ SRFGUN CONVERSION TO BOOSTER  
Heat leak upstream beam line configuration checked  
Cooldown requirements specified for VTF test at Fermi/TJNL due to test with cavity+helium vessel
- Control and Instrumentation system  
Updated cable tray requirements for D. Phillips  
PT and Cernox Instruments ordered  
Heater Control Centers specified and quoted.  
Control logic document completed but need to be updated for new tags

### **Commissioning:**

- Commissioning plans and steps are under preparation
- The controlled beam losses clearly observed using CEC beam loss monitors. Work in progress. Similar system will be used at LEReC.
- Beam emittance measurement based on slits are in testing now at CEC. Looks very promising.

### **Installation and other Design work summary:**

- Design work continues on cathode systems for testing the DC Gun:
  - a. The cathode rolling transport system (from the cathode coating system in the RHIC tunnel) design has been completed. Detailed fabrication drawings are being checked before they are released for manufacturing and procurement.
  - b. The cathode transport system (from the rolling cart to the DC gun HV cathode holder) modeling in complete. Detailed fabrication drawings are 90% complete and have been reviewed. Magnetic manipulators and the large translation bellows for the system have been ordered; the bellows are in house.
  - c. A review of the vacuum pumps and instrumentation needed for the cathode systems was completed and the vacuum system Process and Interface Diagram is being prepared.
- The DC gun is being assembled at Cornell.
- Multiple meetings were held on the work platform needed to access the DC gun and the SCRF booster cavity equipment from above and the meetings continue
  - a. The vendor for the structural elements for the work platform visited and is preparing cost estimate for manufacturing those components.
  - b. Drawings were also forwarded to the local cleanroom component vendor for estimates on the HEPA filter and fan systems and support systems.
  - c. RF waveguide positioning for the SCRF Booster Cavity and the 2.1 GHz cavity have been defined.

- d. The laser transport line is being laid into the overall tunnel model and being reviewed and the tunnel optics table is being modeled.
- Design and Modeling of the transport line between the DC gun and the Booster cavity are near complete.
  - a. The three custom vacuum chambers required for this section are in checking. Preliminary drawings have been sent to vacuum equipment manufacturer for a cost and manufacturing time estimate.
  - b. The mirror assemblies are also in checking. Bids are being received for manufacturing and polishing the mirrors; the choice of mirror material – copper or stainless steel – and plating will be made soon based on vendor feedback.
  - c. The window specifications for transmitting the lasers into vacuum have been defined.
  - d. The profile monitor for this beamline section has been modeled. Fabrication drawings are being prepared.
- The rest of the transport line after the Booster cavity position has been laid out.